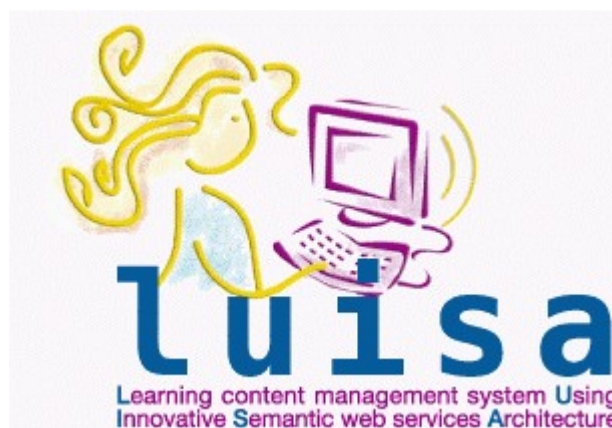


LUISA

Learning Content Management System Using Innovative Semantic Web Services Architecture

IST- FP6 - 027149



Deliverable 3.1

**State of the art –
SWS Infrastructure, Annotation, LCMS**

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EXECUTIVE SUMMARY

This deliverable presents the state of the art in the technical fields of Semantic Web Services (SWS) infrastructure, annotation, and Learning Content Management System (LCMS). These techniques will be used in LUISA and this report presents them in the order they are mentioned above.

The first chapter deals with the field of SWS and describes what a service is, some theory behind the Service Oriented Architecture (SOA), the way it is realised today by Web Services, and the latest in research of SWS. Although several implementations of Web Services and standards for communication between them exist, the composition of Web Services has to be done mainly by hand. The idea of SWS is to describe the Web Services with semantics to make the (semi-)automated composition of Web Services possible.

The annotation part of this document starts with some history of annotation and metadata. The importance of metadata has increased with the growing popularity of the Internet, and annotation tools have gone from existing only inside applications to being standalone applications themselves. The standards that exists today are unfortunately not efficient when it comes to configuring an interface that is to be used for annotation. A comparison between some existing and interesting annotation tools is done in the last chapter of the annotation part.

The sections about LCMS describe several aspects of how a system is built in order to support learning, like for example, the Authoring process, that is the process of composing a course from a set of so called Learning Objects. In order to keep the access rights to the Learning Objects, a DRM chapter is included. At the end of the document a list of different kind LCMS and project in that field is presented.

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1 INTRODUCTION

The initial idea of Internet and the Web was to share resources and knowledge in an easy way between different systems and computers. Much has happened since then and a lot of steps have been taken to realize the Semantic Web. Several standards now exist, such as RDF and OWL. The latest trend of how to further semantically enrich the web and allow the discovery and execution of services, is the idea of Semantic Web Services and the emerging standards for that are OWL-S and WSMO. The idea of LUISA is to use Semantic Web Services in the field of TEL (Technology Enhanced Learning) following the WSMO approach.

Within TEL the use of learning objects is helped by rich descriptions in the form of various metadata standards, most specifically IEEE/LOM[52]. These metadata records need to be authored using annotation tools. Many annotation tools of today have deficiencies such as weak adaptability to the domain specific requirements, standard compliance, interoperability with other tools, etc. Furthermore, annotation tools that are up to the task of editing learning object metadata are often XML centric and have weak or no support for semantic web expressions.

Learning Objects are often authored, described, searched for and delivered within Learning Content Management System (LCMS). It is a challenge to find bridges between such centralized and hugely standardized solutions with Semantic Web Services and domain specific flexible annotation tools. This report will give an overview of how LCMS works today and the standards and common practices it relies on.

1.1 Scope of this document

This document describes the state of the art within three areas of research. Section 2 and 3 introduce Semantic Web Services. Section 4, 5, and 6 discuss issues around metadata annotation. Section 7, 8, and 9 give an overview of LCMS and Technology Enhanced Learning in general. And finally section 10 introduces DRM technologies for learning.

1.2 Acronyms and abbreviations

The following section describes what some abbreviations used frequently in the document stand for:

LO – Learning Object, which can be defined as : An entity you can learn from

WS – Web Services

SWS – Semantic Web Services of which WSMO is an example.

Annotation techniques – In this context we are referring to techniques for editing semantic information, basically in the form of RDF or WSML.

SOA – Service Oriented Architecture

LOMR – Learning Object Metadata Repository for storing information around LOM records in a way that allows machine processability.

LCMS – Learning Content Management Systems, software which aids the learning by providing access to material and also takes care of the surrounding administration for you.

DRM – Digital Rights Management, any technology used to protect the interests of owners of content and services.

TEL – Technology Enhanced Learning, learning supported by non-traditional technologies

ESB – Enterprise Service Bus

SEBS – Semantic Empowered Service Bus

SOA – Service Oriented Architecture

SSOA – Semantic Service Oriented Architecture

2 SWS INFRASTRUCTURE

In this section a brief overview of the Semantic Web Services field is provided. The objective is two fold. On the one hand to provide the LUISA partners with a comprehensive view of the Semantic Web Services field that helps bringing all of them to the same level of knowledge. On the other hand, to provide a complete guide of the field that helps the consortium to address the technological decisions that are to be taken in the coming months.

2.1 Services

Roughly speaking, a service is *a piece of software that implements some well-defined functionality that can be consumed by clients (e.g. other services), regardless the application or business model. Services communicate with each other by means of message exchanges.*

Notice that the definition provides a high level conceptual understanding of what a service is, not going into implementation and specification details, which are of no importance at this level. In particular it does not make any assumption about the underlying communication framework nor the specifications used for describing services. It only states that a service has some capability and communicates using messages, thus aiming at giving a clear conceptualization that can be realized in a number of different ways.

The main advantages provided by the use of services revolve around the interoperability, loose coupling, isolation, composability and machine processability.

- **Interoperability.** Interoperability aims at providing seamless connections among software applications. Services allow programs written in different languages, deployed over different platforms and using different protocols to communicate with each other thus favouring interoperability.
- **Loose coupling.** Decoupling or loose coupling refers to the degree of mutual dependency among services. Services expose rich and well-defined message interfaces which allow them to communicate with other services reducing mutual dependencies.
- **Isolation.** It deals with the ability to modify services or their details not impacting other services that might interact with them. Service consumers are abstracted from details of service implementation and location.
- **Composability.** Service composition approaches the problem of the creation and provision of complex value-added services out of simpler ones with the aim of achieving new functionality. Services can be easily composed with each other in order to achieve more complex operations and sophisticated added-value services[21].
- **Machine procesability.** Deals with the ability of computers to process service descriptions. Thanks to the use of agreed specifications computers can lively process services descriptions favoring their interoperability, loose coupling, isolation and composability among others.

2.2 Service Oriented Architecture (SOA)

SOA is an architectural style for building software applications that use services available in a network such as the web as main building blocks [21]. The ultimate goal of SOA is to promote loose coupling while increases interoperability among software components so that they can be reused.

Figure 1¹, shows the evolution in software architectures. It starts back in 1970 with the monolithic architectures, ending nowadays when SOA represent the ultimate architectural paradigm. The evolution path clearly shows an aim for decreasing coupling while increasing interoperability with stronger emphasis on standardized approaches.

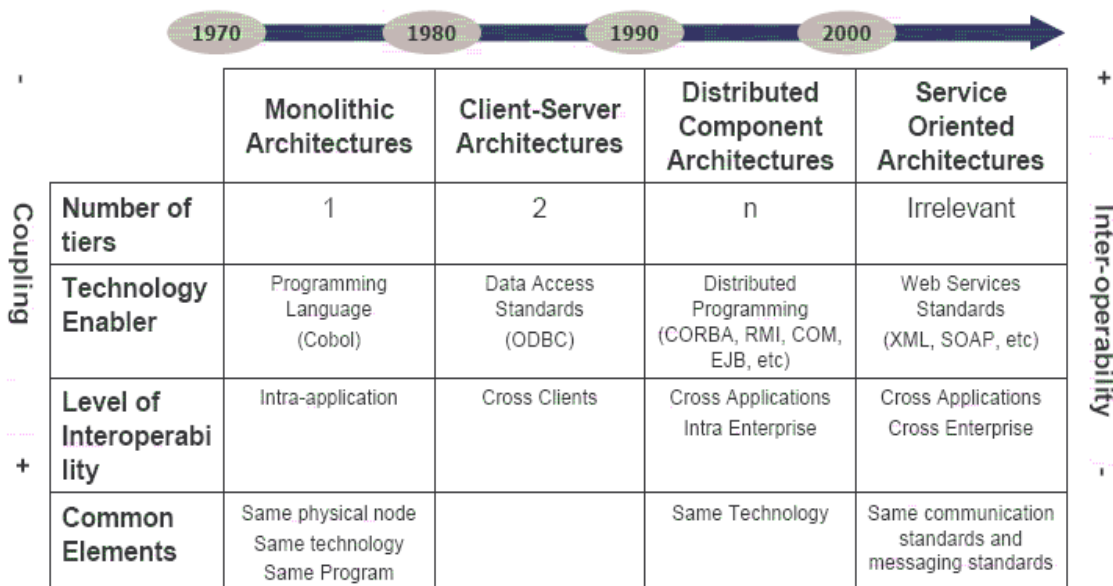


Figure 1: Software architectures evolution

The ultimate aim of a SOA is that of providing ubiquitous and autonomous sets of services that dynamically interoperate to achieve common goals. In this direction a SOA provides a vendor-neutral communications framework with the potential to implement highly interoperable service descriptions and message structures.

2.3 Web Services

According to the W3C a Web Service [1] is a *software system designed to support interoperable machine-to-machine interaction over a network. It has an interface described in a machine-processable format (specifically WSDL). Other systems interact with the Web Service in a manner prescribed by its description using SOAP messages, typically conveyed using HTTP with an XML serialization in conjunction with other Web-related standards.*

In simple terms, Web Services are software machinery accessible via the Web. A Web Service can provide any type of functionality, ranging from mere information providers (such as stock quotes, weather forecasts, or news

¹Keller, S. and Aegert, C.: „Service Oriented Architectures“

aggregation) to more elaborate ones that may have some impact in the real world (such as book sellers, plane ticket sellers, or e-banking), basically any functionality offered by the current Web can be envisioned as a Web Service.

Web Services are the most used way to realize the service and SOA paradigm. In contrast to Services, Web Service due tackle implementation details being linked to concrete specifications and protocols (WSDL, SOAP, XML and HTTP). As far as SOA concerns, it is important to notice that SOA and Web Services are two different things, but Web Services are currently the preferred standards-based way to realize SOA [21]. Other alternatives such as REST [7] are available for describing and implementing services.

2.4 Semantic Web Services (SWS)

The main drawback of traditional Web Services is their lack of proper support for machine processable semantics. This lack makes necessary human intervention to actually discover, combine, and execute Services. The goal is to minimize any human intervention, so the integration of business logics can be done in a task-driven way and with the least support from the user side.

The combination of Semantic Web technology [4],[5], namely ontologies, and Web Services, has been termed Semantic Web Services. Semantic Web Services are defined as *“Self-contained, self-describing, semantically marked-up software resources that can be published, discovered, composed and executed across the Web in a task driven semi-automatic way”*[1].

The Semantic Web in general and Ontologies in particular offer the means to describe the capabilities of Services, the protocol used and the data interchanged while communicating, and the business models in a shared vocabulary that can be understood and/or aligned as required. Such a shared functional description is the key element towards the vision of Semantic Web Services and in particular, sets the foundational basis to realize the semantic Web Service usage process. Such process is made of seven different phases, namely: discovery, negotiation, composition, mediation, execution, monitoring, and compensation.

In a nutshell, Semantic Web Services will allow the development and execution of a higher level of Services that will solve increasingly complex tasks by making available new composed Services. The goal is to minimize any human intervention, so the usage process of Semantic Web Services can be done in a semi-automatic way.

2.5 Semantic Service Oriented Architecture (SSOA)

SOAs present insufficient support when the composed services use heterogeneous terminologies for representing the business model they serve. By combining the architectural principles of an SOA, with the machine understandability and processability of the Semantic Web, this limitation can be easily overcome, thus giving birth to a new architectural paradigm termed Semantic Service Oriented Architecture (SSOA).

An SSOA represent the next natural step in the evolution of SOA where the main building blocks are Semantic Web Services. Every SSOA encloses the same foundational principles of a traditional SOA, plus the incorporation of

semantic support. By these means resources using heterogeneous terminologies and understandings can be shared among different systems and platforms enabling the agile discovery, negotiation, composition and interoperation of services in a task-driven way.

In a nutshell, a SSOA is a robust and complete architectural style where Semantic Web Services are the core building block.

2.6 Enterprise Service Bus (ESB)

Enterprise Service Bus (ESB) represents a new type of application integration middleware that provides foundational services for more complex service-oriented architectures via an event-driven and XML-based messaging engine, the bus.

ESB provides support for data transformation, intelligent routing and communication mediation, resource connection via adapters or specific communication protocols, process coordination or orchestration, management of security and quality of services aspects while guaranteeing message delivery. The result is a more flexible approach to application integration that solves in a very simple way the synchronization requirements across two or more applications.

ESB facilitates an abstraction layer which allows exploiting the value of messaging while keeping a simple architectural model. It acts as a lightweight, ubiquitous integration backbone through which software services and application components flow [8],[11].

In a nutshell, an ESB represents the backbone that transports and routes messages enabling the standards-based integration in a Service-Oriented Architecture. Figure 2 shows a schematic of an ESB² that nicely integrates multiplatform, enterprise and custom applications together with heterogeneous data sources into a common channel that provides intelligent routing and advanced communication facilities among others.

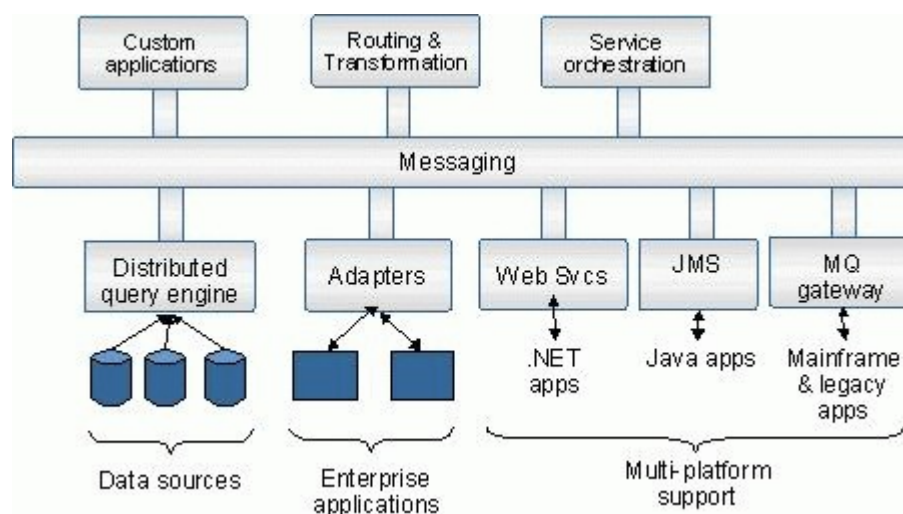


Figure 2: ESB schematic

² Taken from: Ibarra, F: "The Enterprise Service Bus: Building Enterprise SOA", http://dev2dev.bea.com/pub/a/2004/12/soa_ibarra.html.

The main advantage of using ESBs as underlying communication infrastructure is that it abstracts Services from a strong coupling in terms of reference and time [12] as posed by current communication paradigm based on message exchanges.

2.7 Semantic Empowered Service Bus (SESB)

Same as in the case of SSOA, Semantic Enterprise Service Bus (SESB) combine the benefits of the Semantic Web with the event driven, intelligent routing and communication mediation facilities available in plain ESBs. SESB represents the perfect communication infrastructure for SSOAs as it includes native semantic support. This supports translates in the seamless integration of semantically heterogeneous applications (e.g. services) into a shared communication mechanism that provides all the means for the reliable, asynchronous and flexible delivery of information.

A number of approaches exist (sTuples [16], Triple Space Computing [12], Semantic Web Spaces [27],[28],[29] and Cspaces [22] that tackle the problem of realizing complete SESB. However, none of them provides a solid and complete implementation of the concepts and ideas behind SESB. Thus, one of the main tasks in this WP, besides defining a complete LUISA reference architecture, will be explore the status and applicability of current initiatives to LUISA. In case none of them suit the project architectural requirements, LUISA will consider realizing a minimal SESB that serves and fulfils the communication requirements of a fully-fledged SSOA.

2.8 Conclusions

This section has provided an overview of the motivations, ideas and main goals behind Semantic Web Services, SOA and their combination and communication middleware. In so doing an overview of the concept of Service was presented that helped to introduce the ideas behind SOA. Later, the concept of Web Service as particular implementation of core services was depicted. Elaborating on this concept, the semantic advantages of Semantic Web Services with respect to traditional Services was introduced, and consequently the use of SSOA as architectural style. Finally, ESB and its semantically enhanced version SESB were brought into scene, representing modular and efficient communication facility for SOA and SSOAs respectively.

Given the aims and objectives of the LUISA project the approach of defining an architecture following the SSOA paradigm seems most promising. Each one of the core architectural building blocks will be realized as a Semantic Web Service, thus benefiting from the dynamism and interoperability facilities they provide. Finally, it is recommended to use an ESB as communication facility among architectural services given its suitability of use in the context of SOA and the advantages provided by a well decoupled and modular design. However this approach might not be feasible in the first prototypes given the adaptation work required by some partners to fit this novel communication approach.

3 CORE TECHNOLOGIES AND INITIATIVES FOR SWS INFRASTRUCTURE

A number of technologies that realize Learning Objects, Semantic Web Services and their execution environments need to be taken under consideration. In this section a brief summary of the technologies relevant for LUISA is provided with the aim of clarifying how they are blended into the LUISA architecture.

3.1 Web Service Modeling Ontology (WSMO)

The Web Service Modelling Ontology (WSMO) [25] is a formal ontology and language for describing the various aspects related to Semantic Web Services. It represents the backbone for the development of:

- Web Service Modelling Language (WSML)
- Web Service Modelling Execution Environment (WSMX)

The objective of WSMO and its surrounding efforts is to define a coherent technology for Semantic Web Services. Means for semi-automated discovery, composition, and execution of Web Services shall be based on logical inference-mechanisms, because of the well-known competences of suchlike techniques, and its appropriateness for the purpose.

WSMO defines the modelling elements for describing several aspects of Semantic Web Services. The conceptual grounding of WSMO is based on the Web Service Modelling Framework (WSMF) [13], wherein four main components are defined:

- **Ontologies** provide the formal semantics to the information used by all other components.
- **Goals** specify objectives that a client may have when consulting a Web Service.
- **Web Services** represent the functional part which must be semantically described in order to allow their semi-automated use.
- **Mediators** used as connectors provide interoperability facilities among the rest of components.

In order to allow suitable logic-based reasoning on Semantic Web Service, the description language has to provide reasonable expressiveness for describing relevant aspects of the Services, together with well defined formal semantics that support effective reasoning. WSMO counts with WSML [8] for the description of ontologies, goals, Web services and mediators. WSML provides a coherent framework that brings together Web technologies with different well-known logical language paradigms (Description Logics [2], Logic Programming [20], and F-logic [17]), as starting points for the development of a number of WSML language variants, based on existing Web standards such as XML Schema and RDF.

WSMX is an execution environment which enables discovery, selection, mediation, invocation and interoperation of Semantic Web Services (SWS). It aims at providing guidelines and justification for an architecture for the SWS

systems. It defines a general architecture together with the main building blocks and the interfaces exposed. WSMX is a reference implementation for WSMO whose development includes defining its conceptual model (which is WSMO), standardizing the execution semantics for the environment, describing the architecture and a software design, and building a working implementation. The mission and ultimate goal of the working group is to define SWS architecture and build a fully fledged enterprise application based on the conceptual model of WSMO.

3.2 Internet Reasoning Service (IRS-III)

The Internet Reasoning Service - IRS - is the Semantic Web Services framework developed by the Knowledge Media Institute (KMi) at the Open University, which allows applications to semantically describe and execute Web services. The IRS supports the provision of semantic reasoning services within the context of the Semantic Web.

IRSIII [10] is a framework and an implemented platform for creating WSMO-based Semantic Web Services, building upon the previous implementation, IRS-II. It acts as a broker mediating between the goals of a user or client and available deployed Web services. IRSIII takes care of finding, composing and invoking appropriate Web services in order to fulfill a client request, thus supporting capability-based invocation. Additionally, IRSIII design is agnostic with respect to implementation details of the underlying Service implementation platform. The IRSIII ontology is based on the WSMO conceptual model meaning that the framework supports services described in WSMO.

IRSIII includes orchestration, choreography and mediation support. Orchestration specifies the control and dataflow of a service, which invokes other services (a composite Service). Choreography models the external behavior of a service defining how to communicate with it in order to consume its functionality. A mediation handler provides functionality to interpret WSMO mediator descriptions including running data mediation rules, invoking mediation services and connecting multiple mediators together. Orchestration, choreography and mediation components are themselves Semantic Web Services. At the lowest level the IRSIII Server uses an HTTP server written in lisp [10] and extended with a SOAP [30] handler.

3.3 Conclusions

This section has presented the core technologies and initiatives in the Semantic Web Services arena. Firstly, the WSMO framework was introduced pinpointing its core building blocks and accompanying efforts, the semantic Web language WSML and the execution framework WSMX. Later, the IRSIII framework for the execution of fully fledged WSMO services depicted.

Given the nicely match among the LUISA requirements and the WSMO design goals as far as Web Compliance, Ontology-Based, Strict Decoupling, Centrality of Mediation etc, WSMO seems to be most suitable technology currently available for the project at this stage. Thus, it is proposed to use WSMO as core technology for the description of SWS and WSML as Semantic Web language. Additionally, IRSIII is envisioned as the most suitable general execution

environment given the knowledge existing in the consortium in this regards and its full fledged compatibility with the WSMO specification. In further stages of the project it seems advisable to also extend the scope of the execution environment to also support WSMX.

4 INTRODUCTION TO ANNOTATION

Learning objects are essential in technology enhanced learning (TEL), but to be able to find them and other resources on a local Intranet or on the Internet there need to be structured information that describes them and their use. We call this information metadata. Sometimes metadata can be automatically extracted from the learning object or the surrounding context but the quality and feasibility of such approaches can be disputed. In chapter 6 and 7 we will investigate various tools and underlying techniques for creating or modifying metadata manually, we will also compare the merits of a set of representative annotation tools.

Annotation tools or editors for metadata are often a part of a larger application and the tool is not always recognized as an independent and reusable component. With the increasing need for interoperability, and the standardized solutions for metadata representation and exchange, the complexity and generic functionality of the annotation task has increased. Before the Internet grew in popularity the communication between applications could be tailored to the occasion. With Internet and the WWW the amount of application exploded and a standardized syntax for exchanging data evolved. For metadata XML is today the most commonly used standard. To agree on meaning of the metadata terms, standard vocabularies like Dublin Core (DC) and IEEE/LOM (Learning Object Metadata) were developed into standards. These standards typically specify a human readable meaning of each tag in an XML document, which is useful for application developers. Unfortunately, for machines to be able to do what they are good at, i.e. reason and process large amounts of data, these standards are of little use. For instance, there were no way for a machine to process the relations or filter out resources according on the context of use. For this purpose the Semantic Web was introduced. Unfortunately, since most common activities on the Internet, like searching and retrieving information, has been supported by heuristic processing of text-masses, they have up until now not contained much semantics for machines. This will hopefully change with the advent of the Semantic Web, which will enable machines to easier draw conclusions and make decisions in a (semi-) automatic way.

With the rise of Semantic Web and richer machine processable descriptions of learning objects there is greater requirements for interoperability, not only by using specific standards but across standards and domains of use. This affects the design of presentation and editor applications by requiring them to handle a greater diversity of metadata, new elements and vocabularies should be discovered and handled more or less automatically.

In the following two sections an analysis of annotation techniques and annotation tools for metadata are described. Section 5 will describe the current technologies and standards in relation to metadata for learning. Section 6 describes a set of representative annotation tools.

5 TECHNOLOGIES AND STANDARDS FOR ANNOTATION

When developing metadata editors there are two paths to take. Either hard code the standard into the editor, requiring it to be further developed when new versions of the standard or domain specific extensions should be supported. Alternatively, focus on underlying principles, abstract models or encodings, of the standard/standards, hence allowing the module to be configured for new versions or extensions. We will focus more on the second approach because of generality and better support for interoperability.

This section will go through some standards, their abstract models and encodings, their usefulness and the inherent problems they pose and then briefly mention some existing technologies for user interface generation.

5.1 Metadata standards

There is a range of metadata standards that have been developed over the years, Marc for library records, Z39.50 protocol for information retrieval, KIF for knowledge representation, PICS and HTML meta tags for categorization of homepages etc. We will only take a brief look at the most influential from the perspective of learning and web based systems.

5.1.1 Dublin Core, a framework for defining and relating terms

The Dublin Core Metadata Initiative started in 1995 and has developed a schema for describing resources that are less specific than LOM. Dublin Core Metadata Element Set [51] comprises 15 metadata elements:

Table 1: Dublin Core Metadata Element Set (DCMES)

1. <i>Title</i>	6. <i>Contributor</i>	11. <i>Source</i>
2. <i>Creator</i>	7. <i>Date</i>	12. <i>Language</i>
3. <i>Subject</i>	8. <i>Type</i>	13. <i>Relation</i>
4. <i>Description</i>	9. <i>Format</i>	14. <i>Coverage</i>
5. <i>Publisher</i>	10. <i>Identifier</i>	15. <i>Rights</i>

These 15 original elements have been complemented with 40 (at the time of writing) new elements like: *Audience*, *Provenance* and *RightsHolder*, some of the new elements are considered as refinements of the original elements, e.g. *Abstract* and *TableOfContents* are refinements of *Description*. A refined element has a narrower meaning than the element it is refining. If an application does not understand a specific element refinement it should resort to the element it was refined from, this assumes the application has knowledge of the refinement. The refinement is typically expressed in a schema. According to terminology introduced in the Dublin Core Abstract Model [24] all these elements are *properties* in *property/value pairs*. A *value* may be a new resource, as is often the case of the *Relation* property, or a string according to an *encoding scheme*. The encoding scheme helps the application interpret the

value by specifying parsing rules or formal notation, for example the *Date* property are often encoded using *W3C-DTF*.

With the introduction of the Dublin Core Abstract Model it has been made clear that Dublin Core is more of a framework for specifying and relating terms in a semantical manner rather than a list of 15 predefined terms. Hence, there is no well defined set of properties and encoding schemes that application must support to be compliant. An application is free to only support two or three properties or for that manner be completely configurable to manage all kinds of new community defined properties. The abstract model is *abstract*, this means that before anything can be expressed you have to specify which language to use. Currently there is encoding guidelines for RDF, XML and HTML meta tags which is less expressive than the other two. There is also work going on to create a Dublin Core Application Profile recommendation for specifying suitable sets of properties and encoding schemes to be used together.

5.1.2 IEEE LOM, syntax and semantics for Learning Object Metadata

IEEE LOM [52] consists of a single hierarchy of 76 data elements divided into nine categories, and specifies vocabularies and allowed syntaxes for the value of each element. The semantics of the data elements is defined in natural language and is sometimes unclear. For instance, when describing a Learning Object the educational category is allowed to occur several times, the effect on the sub-data elements of this category is unclear. One interpretation, perhaps reasonable, would be that the sub-data elements of each educational category instance says something of the learning object in an *educational context*, specified by the sub-data elements 'context' and 'Intended end user role'.

Extensions to IEEE LOM can be made by inventing new data elements, or by defining new vocabulary terms. Refinement of data elements as allowed in the Dublin Core Abstract Model is explicitly forbidden. Furthermore, the guidelines for extending LOM are rather weak due to the lack of a well defined semantics. The XML binding [19] describes how extensions are allowed with attributes and elements. But if an extension were to be defined in the hierarchical model of LOM, it is not explicitly stated how this would be expressed in the XML binding. The other way around is also problematic, e.g. the XML binding allows new attributes even on the LOM data elements which have no correspondence in the hierarchical model.

5.2 XML Schema, RDF Schema, OWL, and WSML

As seen above many of the metadata standards are expressed independent of how they should be expressed and exchanged. As a consequence application developers need to choose a language to support, e.g. RDF or XML. Furthermore, the application needs to have an internal representation of the standard in the form of an API. One solution is to rely on an API for a specific language and support other languages via import or export. For Dublin Core relying on an RDF API should work quite well since the Dublin Core Abstract Model is very close to the RDF semantics. For IEEE LOM, the XML DOM API is currently the only choice since this is the only standardized binding. Unfortunately this solution carries with the problems of unclear semantics and lack of interoperability for extensions as mentioned above. Another interesting

possibility is the initiative to map IEEE LOM onto the Dublin Core Abstract Model. In that case it would be possible to express metadata with expressions from both standards in a manner that makes sense semantically.

When standards are expressed in a language there is a formal description how the expression looks like. For XML it is the XML Schema Definition, or XSD for short. For RDF there is RDF Schema or RDF Vocabulary Description Language to be more correct. An XSD specifies a specific type of XML document with a tree of XML elements and the belonging attributes. An RDF schema specifies a set of classes, properties with domain and range restrictions, and subclass and sub property relations.

We will now discuss XML Schema, RDF schema and OWL from the perspective of how they are useful for configuring metadata editors. None of the three are fully satisfying. Hence, we will try to describe some of the most obvious problems so that we can come back to them in later sections and discuss complementary solutions.

5.2.1 How is XML Schema useful

There are many generic XML editors that can validate and help the user writing XML according to an XML Schema Definition, XSD for short. However, since most XSDs for metadata, like IEEE LOM, there is no mixing of free text with elements, no entities and very few attributes, such editors are way to advanced for the purpose. Even XML WYSIWYG editors still don't come close to the usability of a dedicated metadata editor.

XML Schema allows specific annotation elements where human readable information or application specific instructions could be expressed. From this it would be possible for a XML based metadata application to generate quite nice user interfaces. Lets concretely look at the XSDs for the XML binding of IEEE LOM:

- There are no annotations provided for the individual elements or the predefined vocabularies.
- There are no multiplicity requirements as specified in the standard as it would impose ordering among the elements which is not expressed in the standard, see Appendix E3 of IEEE LOM XML binding [19] for more information on this issue.
- Since the standard allows domain specific vocabularies, the connection to a specific vocabulary cannot be made in general

Optimally, to be able to generate good user interface from an XSD for IEEE LOM extend the existing XSDs to make decisions on order and which elements to include, express useful human readable descriptions and labels in annotations (preferably in many languages), and decide on the vocabularies to use is needed. However, this does not seem to be the path taken by application developers. On the contrary they provide their own configuration files, a kind of profiles. The profiles provide the missing information and in practice restrict the role of the XSDs to validation. A possible explanation for this behaviour could be the mismatch between the complex capabilities of XSD with the quite simple XML metadata documents managed in practice.

5.2.2 How is RDF Schema useful

Generic RDF editors, (not editors for RDF Schema), fall in three categories, graph-, triple-, and resource-centric. The first two are of little use from the perspective of making use of RDF Schemas and for that matter for working with metadata for learning. This is simply because it is not in their nature to provide guidance and restrictions according to RDF Schemas / specific metadata standards. The third category, the resource-centric applications, are more appropriate if they can make use of RDF schemas, especially in combination with additional configurations. The resource centric editors are typically form-based applications, perhaps web based, with free-text fields and drop-down boxes.

RDF schema, or the more correct name RDF vocabulary language, provides definitions of classes and properties and their subclass or sub-property relations. Additionally, it contains mechanisms for expressing descriptions and labels on the classes and properties which can be used for generating a suitable user interface. In fact, contrary to the IEEE LOM XML binding the DC RDF schema provides quite a lot of human readable descriptions in several languages. Perhaps this is due to the fact that the focus of RDF schema is to express semantics rather than syntax.

RDF schema is unfortunately not enough to fully configure an editor for learning metadata:

- **Cardinality.** It is not possible to express minimum and maximum cardinality on property occurrences on individual resources in RDF Schema. In fact, since not all statements about a resource need to be in the same RDF graph, and RDF graphs are allowed to be merged, it would be hard to enforce such restrictions.
- **Selection of properties.** The amount of properties to use in a certain context should be configurable. Clearly, if the resource is an instance of a specific class, only those properties that have an appropriate domain could be filtered out. On the other hand, not all type information is made explicit. In fact adding a property on a resource will imply that that resource is an instance of the class that is the domain of the property.
- **Order of properties.** The order of properties should be configurable. For example, a typical situation is to have the most relevant or common properties presented first. In RDF there is the `rdf:Seq` container which provides order, however it is not used in RDF Schema.
- **Grouping of properties.** IEEE LOM provides nine categories for easier overview. One option is to make use of intermediate resources and apply the properties on them instead. However, since this changes the semantics and creates interoperability hurdles, it is not a recommended path to take.
- **Language control.** When the range of a property is a string there is an additional and optional language encoding, e.g. the Dublin Core title. Unfortunately there is neither a way to enforce nor to disallow this.

Now, there is at least three ways to avoid these problems. The first one is to hard code a lot of sensible defaults and perhaps pre-knowledge of a range of

standards; this option is not the focus of this report. Second, you can complement the RDF Schema with a configuration; this approach will be further discussed in sections 5.3 and 5.4. Third, you could make the effort to convert the RDF Schema to an OWL ontology, some problems persists though.

5.2.3 How is OWL useful

OWL is the next level in the Semantic Web stack. Beyond what is already provided by RDF Schema, OWL provides vocabulary for describing properties and classes; among others, relations between classes (e.g. disjointness), cardinality (e.g. "exactly one"), equality, richer typing of properties, characteristics of properties (e.g. symmetry), and enumerated classes. Furthermore, OWL expresses information in ontologies, which can include other ontologies.

Generic editors for OWL tends to be ontology-centric rather than graph, triple or resource centric as for RDF Schema editors. To be an ontology-centric editor involves editing the ontology header, the axioms for classes and properties as well as fact about individuals. From the perspective of an editor for learning metadata, this translates to editing the metadata standard itself as well as the resources that are to be described according to the standard. In the world of learning metadata applications you might modify / extend the standard to adapt to the needs of a community, e.g. specifying which metadata elements / properties and vocabularies to use, but this is a separate process from marking up resources in an editor. Hence, to align with the word of learning metadata an editor which only allows expressing facts about individuals would be needed. Some care has to be taken since in OWL Full classes are allowed to be individuals as well.

Two of the problems listed for RDF Schema can be solved with OWL:

- **Cardinality**, with OWL Lite you can provide maximum and minimum cardinality of zero and one. With OWL DL or OWL Full there is no restrictions on what cardinalities you can specify.
- **Selection of properties**, the amount of properties available is possible to control when you create an ontology. Compared to RDF Schema where there is no clear scope of which properties that are defined together (namespaces should be considered opaque and RDF graphs are allowed to be merged), the ontology header in an OWL ontolgy specifies clearly if anything else is to be included. However, this does not allow to configure smaller sets of properties for specific purposes, except of course if classes and range restrictions are used for this purpose.

Hence, to be able to solve the other problems listed for RDF Schema still additional configurations for editors would be needed. It is necessary to point out that such additional configurations should not contradict or replace a given RDF Schema or OWL ontology provided, rather they should be complementary.

5.2.4 How is WSMO useful

In LUISA the Web Service Modelling Ontology (WSMO) will be used to realize the Semantic Web Services. The language to describe the ontologies in WSMO

is the Web Service Modelling Language (WSML) [8], which is divided up into several parts. WSML is more powerful than OWL, but for the purpose of editing learning object instances WSML Description Logic (WSML-DL) is sufficient. However, WSML-DL provide nothing further to annotation than RDF Schema and OWL, and a partial mapping from WSML to both RDF [9] and OWL [8] exists. This means that the problems of OWL and RDF Schema persist in WSML. Furthermore, WSML has an RDF expression with reasonable semantics. Hence no extra support is needed for being WSML compliant in RDF capable annotation editors. And no extra effort is needed when editing WSML compared to RDF or OWL.

5.3 Application Profiles

Most metadata standards have a set of well developed scenarios from where the motivation and extent of the standards are drawn. If the set of scenarios is very large the resulting standard will either be quite generic or very huge. Unfortunately, a huge metadata standards also requires huge coordinated efforts where consensus can be reached. This leaves us with generic metadata standards which do not really fit perfectly. Hence, another approach to avoid the interoperability problems that would arise if everyone do their own extensions is needed. The candidate approach is to focus on small metadata standards and then allow resources to be annotated with metadata from several metadata standards. This requires that the metadata standards lend themselves to mixing, which is one of the purposes of introducing a common 'abstract model' for metadata like DCAM.

The idea of application profiles is to describe how to mix and match metadata terms / elements / properties from existing vocabularies / schemas / ontologies for a certain application (or situation). In [14] the use of a application profiles are described as:

Typically implementors are part of larger communities, they form part of a sector (education, cultural heritage, industry, government), possibly a subject grouping, they are part of programmes with common funding, they work with others serving the same target audiences. In order to work effectively these communities need to share information about the way they are implementing standards. Communities can start to align practice and develop common approaches by sharing their application profiles.

Lately, an initiative has started for defining Application Profiles more formally within Dublin Core. Currently a document with guidelines is available [3]. This document does not provide a machine readable expression but briefly mentions earlier attempts in this line, such as SCHEMAS and MEG. All these initiatives focuses on reusing and refining terms accompanied with context specific vocabulary restrictions.

Even if application profiles would be ready today for machine processing, they would not solve all the issues mentioned above for RDF Schema. E.g. all the three initiatives lack capabilities for specifying cardinality, order and grouping.

5.4 Fresnel

Fresnel [6] is a vocabulary for displaying RDF in a browser independent fashion. Fresnel introduces the concept of a *lens* to specify a set of properties that should be displayed for a certain set of resources. Separately it provides *formats* for specifying formatting instructions on individual properties or sets of resources. Fresnel also defines selectors for lenses and formats and how to prioritize between matched lenses and formats. A specific language called Fresnel Selector language, which can be understood as XPath for RDF, is introduced solely for this purpose.

Fresnel makes use of RDF Schemas when they are available for labelling and for prioritizing between lenses and formats. Of the raised issues for RDF Schema, Fresnel manages all of them except cardinality restrictions and language control. Since Fresnel is for presentation purposes this is hardly a surprise. To extend Fresnel to be useful for configuring editors seems to be feasible on a technical level and the documents describing Fresnel clearly states that an editor extensions is encouraged.

On a side note, Fresnel lenses can be seen as machine readable application profiles, except that they are more capable and work on the level of RDF rather on a higher abstract level such as DCAM. Since DCAM and RDF semantics are quite close it might be possible to modify Fresnel to be independent of RDF, although not necessarily of interest to anyone.

5.5 Summary and conclusions

In this section we have gone through metadata standards, schema alternatives, application profiles, and Fresnel. We have discussed lack of semantics in IEEE LOM and briefly touched the interoperability problems that arises when extending it. We have also seen how Dublin Core dodges this problem by a stricter semantics and the approach with an abstract model.

After that we discussed the problems with solely relying on XML Schema, RDF Schema, OWL or WSMML when automatically configuring generic editors for metadata. We have also seen how application profiles does not provide enough complementary information to help the situation, although they are useful for encouraging interoperability. Eventually we have seen how Fresnel could be extended to be the missing link that allows reuse of standards in a 'mix and match' and still provide the configurations necessary for a generic metadata editor.

In LUISA we will need to provide user friendly editors for WSMML expressions of IEEE LOM. Or, more correctly, we will need editors for different *profiles* of IEEE LOM according to the use case at hand which should be generalizable to any community of practice in the future. We have also seen that a solution that provides support for RDF Schema or OWL will be sufficient for editing WSMML instances. Hence, a recommended path for LUISA is to develop a Fresnel editor extension. This Fresnel editor extension would provide the needed extra configurations which together with the Use-case ontologies expressed in RDF Schema or OWL would be input to a generic metadata editor that could generate the required editors.

6 ANNOTATION TOOLS

In this section we will go through a representative but not exhaustive set of metadata editors. The editors considered are editors of *metadata for resources*, not editors for markup of pieces of text. The main aspects considered are:

- *Configurable with respect to:*
 - **UI language** – weather the application is internationalized
 - **Profile** – which metadata elements to use, their labels and vocabularies.
- *Specific Metadata:*
 - **Standard or Principle** – is the metadata supported in this application bound to a specific standard or can it work with any metadata according to a *schema, ontology, or profile*?
 - **Format** – how is the information/metadata stored, e.g. in XML, RDF, or OWL?
- *Implementation:*
 - **Type of Client** – is the client an application, i.e. a downloadable executable, or is it web based?
 - **Modularized**, for an editor to be categorized as modularized it should be simple to integrate into other applications with reasonable well defined interfaces and not to tightly tied to the internals of an existing system.

Table 2: A comparison of metadata editors

	Configurable w.r.t.		Specific Metadata		Implementation	
	UI language	Profile	Principle or standard	Format	Type of Client	Modularized
SMORE	No	No	Ontology	OWL	App	No
Protege	No	No	Ontology	OWL etc.	App	No
SHAME	Yes	Yes	Profile	RDF	Web, App	Yes
Reggie	Yes	Yes	Profile	RDF	App	Yes
DCDot	No	No	DC	RDF	Web, App	Yes
ImseVimse	No	No	LOM / DC	XML/ RDF	App	Yes
LOM-Editor	No	No	LOM	XML	App	Yes
Reload editor	No	Yes	SCORM / LOM Profiles	XML	App	Yes

6.1 SMORE (Semantic Markup, Ontology, and RDF Editor)

This Editor is a standalone application designed to enable markup of web pages in OWL by using Web Ontologies. The application contains a web browser where you can work with the actual webpage that you are annotating. There is also window for building and exploring various ontologies. Ontologies can be created in the tool and uploaded to a central server for sharing and reuse. All the annotated information is saved in OWL-RDF. There is a similar tool called OntoMat annotizer which has largely the same functionality.

6.2 Protégé

Protégé is a very capable and popular ontology editor. It comes in two flavours, Protégé-Frames and Protégé-OWL. Both versions provides a plugin framework wherein numerous plugins have been developed for purposes such as visualization, import / export, project management, reasoning, validation etc. Even though Protégé is a dedicated ontology editor there are plugins that extend it in the direction of SMORE for simple web page categorization. Protégé-OWL can work with both OWL and RDF Schema. Unfortunately, according to the discussion regarding generic ontology editors in section 5.2.3 it is much too complicated to use as a pure metadata editor. However, it would be possible to provide a dedicated plugin that given an ontology and some further configuration as discussed in section 5.2.3 would generate a nice editor.

6.3 SHAME

This is a framework for constructing metadata editors, but also for creating presentations and query interfaces. Nearly all kind of metadata expressed in RDF can be edited by specifying a *graph pattern* and *template form* pair from which an editor can be generated. The graph pattern specifies how the data is expressed in RDF while the form template specifies how the resulting form should look. The form template also provides complementary information to RDF Schema as discussed in section 5.2.2, e.g. cardinality, ordering, and grouping.

The editor generation is provided in both an application and a web settings. SHAME is intended to be a library that should be easily integrated into bigger systems that need advanced and flexible metadata editing, presentation or search.

6.4 Reggie – The metadata editor

This standalone application is made for easy creation of various kinds of metadata. The application is configured through profiles which specifies which elements and in which order they should be available. The profile also specifies a label, a description, and a datatype / vocabulary restriction for each element. Remarkably though the profiles seems to lack a sensible cardinality control otherwise the profiles seem to be quite complete for regulating direct properties. The metadata it produces is RDF, however this metadata does not seem to fit the latest RDF specifications. Additionally, the application itself provides the

possibility to decide which fields to display at a time except for those that are explicitly required.

6.5 DCDot

This application is available both as a web based version and a stand-alone application. The metadata edited by the application is fixed to the original 15 elements of Dublin Core with the aim of describing resources on the web. DCDot can also extract existing Dublin Core metadata embedded within documents to help the user doing the annotation.

6.6 ImseVimse

This editor was initially part of a bigger application and broken out for better maintenance and reuse. It is capable of editing IMS LOM version 1.2 and has a compatibility view of the 15 Dublin Core properties as specified in the standard. It also supports experimental support for exporting to the RDF binding of IMS LOM version 1.2. This support is now out of date for several reasons, first LOM is now developed by IEEE instead of IMS, second the RDF binding was initially also moved to IEEE and then abandoned altogether. Instead the binding to RDF will occur automatically when the planned mapping of IEEE LOM to the Dublin Core Abstract Model is finished.

6.7 LOM-Editor

The LOM-Editor is an application for annotating learning objects with metadata from the IEEE LOM standard and it writes XML either directly to a file or to an XML-database. The user interface presents all the categories and their fields in order for the user to fill them in.

6.8 Reload editor

This editor is an part of an application suite tailored to support various learning standards and is developed within the RELOAD project³. The purpose of the editor is to edit resources in the form of learning objects with metadata from e-learning standards such as IEEE LOM and SCORM. Inside the application you can create your own metadata profile that is used to create editors that have your own restricted set of elements and the name of the elements. You can also define new vocabularies instead of the ones provided in the standard. The profiles can be read from reload specific XML-files that are configured manually outside the application. The metadata is in the form of XML.

6.9 Summary and conclusions

We have gone through a set of representative annotation tools that edits according to ontologies, profiles or fixed standards such as Dublin Core and IEEE /LOM. We have also briefly summarized them according to implementation choices and configurability.

From the perspective of LUISA a modular solution which can be integrated in a web based system is needed. In section 5.5 it was concluded that a solution would need to support profiles which further restricts the set of possible

³ <http://www.reload.ac.uk/index.html>

applications. The editor should also manage WSML. This issue requires at least support for RDF. Hence, most of the applications is then unsuitable for the need:

- SMORE is too ontology centric and Protégé (even with a plugin for a profile configured instance editor) is still neither modular enough nor available in a web setting to fit the needs.
- DCDot, ImseVimse, and LOM-Editor all support only a fixed metadata standard.
- Reload editor is configurable but works only with XML.

This leaves only SHAME and Reggie. Unfortunately, Reggie does not seem to be actively developed any more and the web based interface is really an applet which puts severe strains on the integration issue.

Hence, the recommendation is further develop SHAME, optimally by supporting the editor extension of Fresnel as discussed in 5.5.

7 INTRODUCTION TO TECHNOLOGY ENHANCED LEARNING

It is only in the last century that education became something for everyone, a must... even if not all over the world .

In this process of access diffusion to education and culture, technology played a role since early stages. In countries it was necessary to develop some sort of “*distance learning*” which was initially supported via regular mail, then radio⁴, then television and nowadays also with Internet. The need for a “*life long learning*” further strengthens the adoption of technology based learning.

Quoting IDC, we can say that e-learning comprises “*educational content, learning services, and delivery solutions that support and enable Internet-based learning.*”

Early examples were Computer Based Training applications (CBTs), followed by CD-ROM (initially conceived in a stand-alone fashion). Then its hybrid version (CD plus Internet) and now fully on-line training courses. In practice, the term e-learning has come to include activities related to learning that are facilitated by the Internet.

Cognitive modelling and ergonomics have been investigated since long time (for instance, [26], [50]) but now the introduction of virtual reality, eye-tracking [49], map reading behaviour [48] and other technologies have moved even further the frontier for e-learning applications. Studies on cognitive architecture have been carried out taking into account perception, cognition, action (motor) and memory [15] while studies on eye movements and visual attention are more closely focused on the eye physical aspect [18].

Artificial intelligence, wireless communication, agents, adaptive user profiling, virtual reality... are other extremely interesting technologies that are used, or can be used, to foster the learning process. In particular it is worth pointing out the benefits coming from the adoption of semantic capabilities both at the content production and content retrieval phase. This is even more relevant if one takes into accounts the problems encountered in daily work by professors and trainers when seeking for content that has to meet specific requirements in terms of provided knowledge or covered topic given the present poor quality of annotation systems.

7.1 Authoring and Content development for E-Learning applications

Producing multimedia applications, especially in the educational field, is a complex, time consuming and costly task.

The editorial board following directions of the pedagogues involved in the course design usually performs content selection, while the legal department performs copyright clearance.

⁴ Africans (RSA and South African Radio Broadcasting Corporation), Spanish (Radio Andorra), Chinese (Radio Beijing), Jew (Israel Broadcasting Authority), French (Radio France International), Japanese (Radio Japan), Greek (Cyprus Broadcasting Corporation), English (BBC, Voice of America in Special English, Radio Australia, KGEI California, WYFR), Dutch (Radio Nederland), Polish (Radio Poland), Russian (Radio Moscow), Swedish (Radio Sweden), German (Deutsche Welle, Deutschlandfunk, Radio DDR)

Authors choose content templates, text, graphics and other media that will constitute the object. Authors build quizzes / test relevant for the course along with related feedback for each response. The feedback can be text, media, animations or other types of instructional material. The behaviour of a course can be based on the learner interactions with test questions.

Authors will preview designed course feature to see the content in action from the perspective of a learner and only when the whole content is ready for deployment, authors can publish it as Web-based content.

This implies that suitable basic assets are already available and catalogued. Often this is not the case and it is necessary to deal with the process of making content available, nominally how to transform in learning objects structured and unstructured content.

The first step would be to properly select and classify content. Then it will be necessary to take textual content and turn it into smaller self-consistent chunks. During this step glossaries of terms will have to be defined and populated. Such glossaries will be available then as complementary/support units. Textual content may present a chapter/paragraph-oriented structure and such sub elements can be either logically related but self confined or logically related and interdependent. In the first case it will be simply necessary to segment text to the smallest self-confined/functional level and transform it into a learning object. In the other case it will be necessary to segment it, structure it and produce a set of interdependent objects (via pre-requisites). Finally it will be necessary also to provide relevant metadata and associate it to produced objects in order to grant easiness in the search & retrieve process.

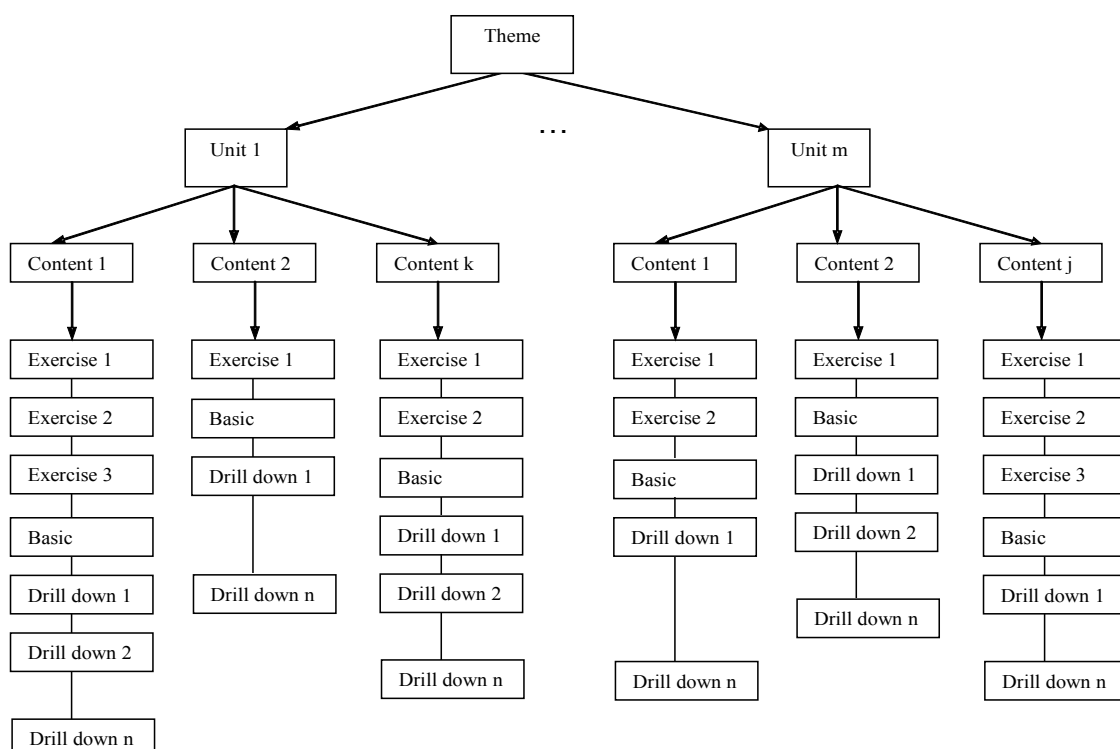


Figure 3: A possible content structure delivered in units with exercises & drill downs

7.2 Authoring Tools and E-learning Content Development Applications

Unlike conventional training, a good instructor cannot rescue bad on-line learning; materials live or die by the quality of their design. Therefore, in e-learning, content and design have remained the most critical dimensions of success. Not surprisingly, the shortage of well-designed, engaging and relevant e-learning products is still high on the list of reasons for limited acceptance of e-learning in many organizations. Furthermore most self-paced learning courses still reflect a traditional course structure. Some of the most effective on-line courses provide Users with some feedback on achieved performances and exploit a pedagogical philosophy based on the following principles:

- Student centered approach (user chose own learning path);
- Each course level revolves around a central theme;
- Activities have a pedagogical rationale;
- The content is interesting and related activities are challenging.

Usually contents are organised in different levels spanning several courses. On the average each course is composed of more than ten units plus a unit test. Units are in turn organized in a way to consist several stimuli with an average of five activities per stimulus plus tests. The course becomes progressively harder while progressing through units. For e-learning solutions foreseeing both the adoption of CD/internet based content delivery it is worth limiting the duration of each learning session to around 15-20 minutes for usability reasons. This brings to the following structure:

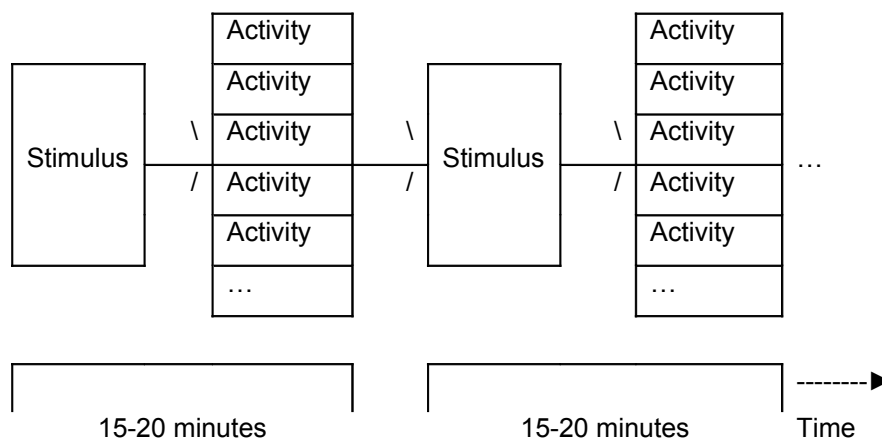


Figure 4: Typical fruition scheme of a learning unit (innovative case)

Usually each stimulus is accompanied by a set of activities focused on different sub-skills that should be acquired.

Test units usually are presented at the end of a set of unit aiming to provide feedback on what learned. Such units may be repeated several times and usually should last no more than thirty minutes each. The structure will comprise a set of stimuli each followed by a set of questions. At the end of the session a score is provided as feedback. Usually the provided score is in the format X out of Y correct answers (i.e. 3/5). Usually if the same exercise is

repeated several times only the best score is reported. Usually there are also entry test units focused on pre-requisites and containing at least three graded texts. They should last no more than twenty minutes be timed and drawn from a bank containing several version of the test (at least three). Such units assign both a level and a course to the user upon completion. This is usually accomplished based on the following decision schema:

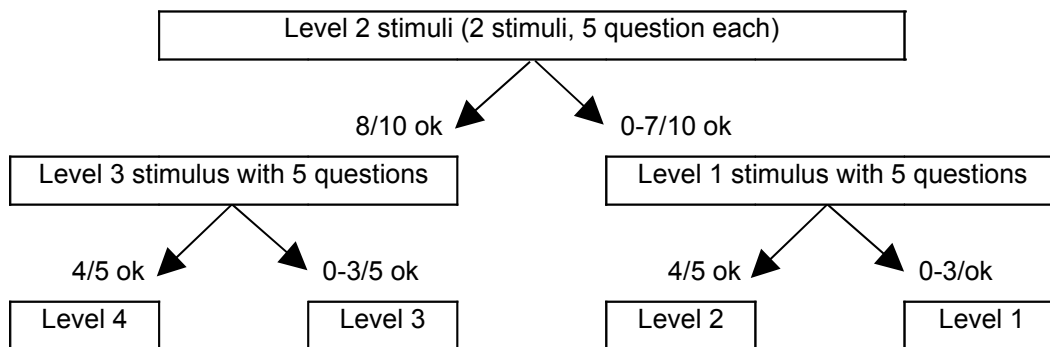


Figure 5: Evaluation exercise scoring and entry level attribution

According to Brandon & Hall report on Design of e-learning Courses for a successful development, it is necessary to take into account:

1. **Faced problem & expected results:** Matching the e-learning solution to the problem at hand; achieving intended results.
2. **Instructional design and integrity:** Structuring, relevance and quality of content, “per-se” and in relation to intended users.
3. **Evaluation & assessment:** Applying imagination and rigor to the design and implementation of evaluation or assessment.
4. **Interactivity:** Using creativity and expert design practices to achieve instructionally powerful interactions of all kinds.
5. **Usability & Interface:** Creating an effective, easy-to-use interface.
6. **Motivation & aesthetics:** Motivating learners to follow and successfully complete the training.
7. **Media & technology:** Smart selection and application of media, development tools and delivery technologies.
8. **Money & time:** Achieving excellence under constrained budgets and time lines.

Furthermore, in defining how to reach and apply best practices in companies and organization it is essential to operate in these areas:

- **Planning & Development**
- **Course Design**
- **Implementation**
- **Managing learner participation**

7.3 Authoring Tools and LCMS

Authoring tools are generally desktop, single-user applications used to construct learning content by assembling and combining text, graphics, audio, video and animations into e-learning courses. Yet one can also consider general purpose Web development tools (visual HTML editors) that also fit into the authoring category. These tools are often used to create standard Web pages, but they can also be used for creating learning applications.

In addition, there are a growing number of authoring tools focused on rapid, template-based development of learning content, sometimes with a specific focus on a particular type of learning application, such as software simulations.

Sometimes there is some confusion between authoring tools and learning content management systems, mostly because both have content creation capabilities. Actually 90% of LCMS products (at least for those reported in Brandon-Hall surveys) have some form of content-authoring built-in. On the other hand, some LCMS suppliers have chosen to focus their efforts on the assembly and management of content. These systems provide flexible integration of content created with third-party tools, and in some cases even come bundled with a popular authoring tool.

Table 3: Samples of Authoring tools by category

General purpose	Web specific	e-learning specific
Authorware	FrontPage	TrainerSoft
Flash	Dreamweaver	Lectora Publisher (Trivantis)
Director		ReadyGo Web Course Builder
ToolBook		Tactic
Quest		DazzlerMax

According to analysis performed by government and research institutions, the rapid growth in such areas as distance learning, technology-enabled assessment, and the increasingly diversified and expanded public-private learning marketplace require to develop new strategies for assuring quality and protecting consumers. Important priorities for the public and private sectors include:

- providing reliable and universally accessible quality information for consumers;
- developing quality assurance mechanisms;
- ensuring that learners have the support they need to make the right decisions about their e-learning options;
- developing policies and practices to ensure privacy;
- create the highest-quality e-learning experiences possible;
- implement new measures & methods for assessing / certifying what users know and are able to do;

- ensure broad & equitable access to e-learning opportunities.

The potential return on investment for both the public and private sectors is enormous. The challenge for businesses is to realize the full potential of e-learning as a driver of productivity and performance gains by making it an integral part of organizational strategy and operations, while for government, the challenge is to create a nurturing policy environment for e-learning and promoting industry self-regulation while balancing citizens' interests and needs.

Virtual reality – in nowadays world the usage of virtual reality is becoming more and more extensive. Usually the primary applications are for professional training, but it is apparent that virtual reality could be easily exploited in many other situations.

Multi-sensorial – it's possible to achieve multi-sensorial stimuli by combining visual, tactile and sound experiences into a unique one. The real challenge is to be able to easily and quickly generate similar situations (potentially involving even smell) for education/edutainment purposes.

Interoperability – by adopting e-learning standards (IEEE, AICC...) it is possible to achieve full interoperability of e-learning platform and to have full content portability.

7.4 Virtual Communities and Forums

Establishing user communities is an extremely powerful way to foster a learning process thanks to the exchange of ideas and cooperative support provided. This approach has a quite long history, nevertheless it's difficult to start up. The following are the most relevant factors that would cause user retention or loss:

Table 4: Most relevant factors causing user retention or loss

Reasons to stay & be active	Reasons to leave
Interesting news provision	Lack of a moderator
Content completeness and topic coverage	Willingness from some participant to impose one's point of view
Possibility to find reply to questions or skilled people to question	Uneasiness to understand content and type of mail received
Skilled, knowledgeable participants	Too much mail is received
There is enough dialogue	Shift in focus
Track of discussions & FAQs	Participants' lack of education
Downloadable documentation ⁵	Lack of downloadable documentation

Therefore actions that help in starting up the discussion in a new-born forum / community can be summarised as follows:

- Promote forum existence by direct contact with people that may be interested to take part and provide useful cooperation

⁵ Case studies, white papers, reference documents, presentations, articles and papers
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- Activate and sustain interesting threads
- Periodically provide contributions from experts
- Select and collect key themes
- Generate FAQs starting from relevant threads
- Simplify messages and replies management process (i.e. introducing also the concept of follow-up message that is not a reply but a related issue)

There is another winning factor that has to be taken into account, nominally: “need”. If the user needs to be part of a certain community, or if the user may find in such community replies to one’s own needs, or even a sense of belonging / ownership, then community success is almost assured (the only real threat in that case may be economical sustainability). An interesting example for this is the German School Net; up to when it was strongly supported (in terms of costs and equipment) by Deutsche Telekom it has been growing and developing. It turned to be extremely important, rich of users (both teachers and students) and data exchange. When Deutsche Telekom stopped its supporting activity then community subsistence has been greatly endangered. Now with the start-up of the European School Net also the German has gained new vitality. Noteworthy it is also the case of eSchoolnet the European Teachers’ portal.

8 MARKET PERSPECTIVES ON E-LEARNING

Much expectation surrounds the Internet and its role in education as e-learning can contribute to the improvement of standards and to the effectiveness of teaching and learning.

What is driving the market can be split among present and future trends, while drivers and inhibitors are reported in the following schemas:

Table 5: Market present & future trends

Today	Tomorrow
Technology training	Performance improvement
Classes for the masses	Personalised learning
Instructor centric	Learner centric
Training when scheduled	Learning on demand
Time to train	Time to perform
Teaching by telling	Learning by doing
Product-based learning	Project based learning
Know what	Know why
Skill and information ⁶	Inquiry, discovery & knowledge
Re-active	Pro-active

Source: Online Courseware Factory Ltd

Table 6: Market Drivers & Inhibitors

Drivers	Inhibitors
Lifelong learning	Technology Compatibility
Economic turbulence	Limitations
Need for continued education	Billing systems
Increased Internet usage	Security concerns
	Price

Source: Uwe Krueger of Realtech (www.realtech.de)

One of the most important issues regarding e-Learning systems is related to its effectiveness in transferring knowledge to the user. Learners' comprehension depends strongly on course structure. Therefore, particular attention must be paid in content annotation, search, selection and retrieval. In addition, content should be designed, developed or adapted for multi-modal delivery to ensure effective content re-usability.

⁶ Mastery basics of the 3R's

A direct consequence of all this is that it's necessary to use technology to lower costs and certainly the adoption of Semantic support to LOs annotation is in line with this need.

8.1 Market Segments

According to IDC e-learning market is segmented in three main areas [47]: **Content, Delivery solutions** and **Services**.

In more detail we have that *Content* providers offer courseware core material (like multimedia assets and course structure) and testing / assessments are included in their expertise.

Companies that provide *Delivery solutions* offer products oriented to course preparation and organisation, such as training authoring tools and learning management systems (LMS), including collaborative software to help course fruition.

Services include all additional features that can bring to better course preparation (Content design), and that are related to course maintenance (Management & hosting) and CRM (Online mentoring).

8.2 Market Offerings

Many products/platforms provide solutions in different areas covering partially or totally all the range of e-Learning offering. In the overall the present offering on the market can be presented as follows:

- *Asynchronous Web Based Software Suites* – Tools suites allowing to convert existing documents into a hierarchical system with relative ease. Relatively little programming or technical expertise should be needed. Key characteristics typically include: secure login, centralized database-centred syllabus, on-line (time-monitored) quizzes, randomised dynamically-generated testing, discussion groups, and integrated email, development tools to ease transition from other media to these products. Most relevant vendors: WebCT and Blackboard.
- *Synchronous (real-time) Web Based Training solutions* – This class of product is most appropriate to facilitate relatively formal, instructor-led, hierarchical learning events, such as a seminar or interactive classroom. Some of these products incorporate "talking head video"; most video-enabled products suffer from poor video quality and tend to require 128KBPS (a.k.a. ISDN class) dial-in connections for acceptable performance. Leading members of this class generally have also the following characteristics: browser-based (firewall friendly), on-line testing, shared whiteboard, web-page sharing/co-browsing, application sharing, integrated polling/surveys, virtual "hand/raising", to indicate when participants have questions, text chat (occasionally private) among participants and presenter, PowerPoint support and ability to record sessions and make them available for on-demand viewing at any time. Sequencing is controlled by a presenter-leader.
- *Application Service Provider (ASP)* – Products available as hosted solutions only. This license arrangement may better fit some needs,

especially where institutions do not have the in-house capability to field technical support teams and servers. Vendors in this category generally offer the following feature set: browser-based, presentation / document / application / desktop / web browser sharing, polling, text chat, record & playback, file transfer, possibility to change the menus for selected languages. Furthermore the provided solution is usually scalable and vendor's customer support personnel can take control of a user's PC system (with the user's approval) to instantly provide live assistance and resolve problems.

- *Learning Portals* – This is an emerging variation of Personal Collaborative Environments and is an attempt to combine student services and community building through an integrated web-enabled system. The use of the term "Learning portal" could imply either the basic software product needed to develop a portal OR the actual use of such software to create a learning experience.
- *Collaborative Software* – This category allows individuals to interact one-to-one, peer-to-peer, or in small groups. May also be referred to as "Instant Messaging", or "Buddy Systems", although some products in this category also represent the older "listserve" email-broadcast technology. This type of tool will become integral in advanced web-based learning programs. Some permit application sharing, voice-over-IP or other useful over-the-web features designed to allow individuals to interact. Currently, this category of software lacks interoperability. The Internet Engineering Task Force's Instant Message and Presence Protocol represents the proposed standard, that may turn functionalities ubiquitous and uniform if successful.
- *Team Groupware* – A new subset of collaborative software aiming to create virtual project groups. "Team groupware" is distinguished from personal collaborative environments by the ability to develop documents synchronously and review asynchronously, centralized user management, one-to-one, one-to-many, and many-to-many capability. Systems are scalable to hundreds of users. Advanced software in this category includes group scheduling, ability to store and review older version of documents, and ability to route items. Systems should also require relatively little technical expertise to manage after installation as projects must be easy to create, edit or terminate.
- *Streaming Media* – Real time and on-demand video/data playback was one of the earliest applications of the commodity Internet. Still unable to compete with the quality or ease of use of regular television, this media continues to develop, anticipating broadband Internet access.
- *Web Based Education Development Tools (Authoring Tools)* – This category attempts to collect basic and single purpose tools that meet specific needs but are not themselves intended to be a turnkey implementation system. They are generally visual authoring tools or programmers tool-kits or meet a very specific web-based need.

In the e-learning market a relevant role is covered by Learning Content Management Systems (or LCMS). At the beginning of 2003 Brandon-Hall

carried out a “*Comparative Analysis of Enterprise Learning Content Management Systems*”. Characteristics taken into account to evaluate LCMS cover aspects like standardization, interoperability, easiness of use, test and assessment capabilities.

8.3 Market Uptake

A recent survey of e-learning professional indicated that standard document creation tools rank at the top in the list of utilities used to create e-learning content. Furthermore, most of them do not require specific programming skills even if they may allow the user to achieve high quality results if used with all their extensions.

The following picture summarises the results of the previously mentioned survey. It is necessary to take into account that to achieve a specific result more tools may be used in combination and this accounts for the reported percentages

Table 7: Tools used to create e-learning content

Tool used to create e-learning content (standard)	%
PowerPoint	66%
Word	63%
Other	16%
Tool used to create e-learning content (specialized)	%
Dreamweaver (can be used by specialized and novice users)	61%
Flash (can be used by specialized and novice users)	47%
Code at the HTML tag level (NotePad, UltraEdit or other text editor)	34%
Traditional authoring tools (Director, Authorware, ToolBook, etc.)	32%
Microsoft FrontPage	26%
Learning content management system (LCMS)	21%
Content authoring tools built-in to an LMS	18%
Rapid e-learning development tools (ReadyGo, Lectora Publisher, Trainersoft, etc.)	13%

8.4 Conclusions

Today the market is quite mature and a wide range of offerings exists. There is no obvious gap or need in the market where new products can flourish. Instead we see a situation where existing providers compete by expanding and enhancing existing platforms and services.

The implication of this is that LUISA should partner with existing providers rather than provide new independent solutions. The relevant offerings include

those described as *Asynchronous Web Based Software Suites*, *Learning Portals* or *LCMS*. Learn Exact and Moodle⁷ are two LCMS systems which have been discussed. Furthermore, to avoid being tied to a specific platform, partnering with several existing providers is even better since it will simplify the process of finding the right level of interfaces between systems.

⁷<http://www.moodle.org>

9 STANDARDISATION IN E-LEARNING

In e-learning sector there are a number of Standardisations Bodies, User Organisations and Content Certification of Conformity Bodies. They produce reference material, reports, guidelines and even regulation documents. Since 1998, there has been rapid growth in the number of bodies working to develop specifications and standards for learning technology interoperability. [46]

The following sections gives a short overview of what the current defined e-learning standards describe and can do.

9.1 IEEE / LOM

IEEE P1484 [52] - describes Learning Object Metadata encompassing:

- lom_technical_type,** // Technical features of the resource.
- lom_educational_type,** // Educational or pedagogic features of the resource.
- lom_rights_type,** // Conditions of the use of the resource.
- lom_relation_type,** // Features of the resource in relationship to other resources.
- lom_annotation_type,** // Comments on the educational use of the resource.
- lom_classification_type,** // Description of a characteristic of the resource by entries in classifications.

It is also possible to specify the human language used by the resource, a textual description of the content, keywords describing the resource, the spatial or temporal characteristics of the intellectual content of the resource. Underlying organizational structure of the resource (atomic, collection, networked, hierarchical, linear), The functional size of the resource.

9.2 IMS Standards

IMS⁸ covers indexing, packaging, user data and much more via several standards:

Table 8: IMS standards

Item	Version	Reference page
Accessibility	V1	http://www.imsglobal.org/accessibility/index.html
Competency (RDCEO)	V1	http://www.imsglobal.org/competencies/index.html
Content Packaging	V1.1.3 Public Draft	http://www.imsglobal.org/content/packaging/index.html
Digital Repositories	V1.0	http://www.imsglobal.org/digitalrepositories/in

⁸<http://www.imsglobal.org/>

Interoperability		dex.html
Enterprise	V1.1	http://www.imsglobal.org/enterprise/index.html
Enterprise services	V2 Public Draft	http://www.imsglobal.org/es/index.html
ePortfolio	V1	http://www.imsglobal.org/ep/index.html
General Services	Web V1	http://www.imsglobal.org/gws/index.html
Learner Information Packaging	V1.0.1	http://www.imsglobal.org/profiles/index.html
Learning Design	V1	http://www.imsglobal.org/learningdesign/index.html
Meta-data	V1.3 Public Draft	http://www.imsglobal.org/metadata/index.html
Question and Test Interoperability	V2.1 Public Draft	http://www.imsglobal.org/question/index.html
Resource List Interoperability	V1.0	http://www.imsglobal.org/rli/index.html
Shareable State Persistence	V1	http://www.imsglobal.org/ssp/index.html
Simple Sequencing	V1.0	http://www.imsglobal.org/simplesequencing/index.html
Vocabulary Definition Exchange	V1	http://www.imsglobal.org/vdex/index.html
Abstract Framework	V1.0	http://www.imsglobal.org/af/index.html
Tools Interoperability Guidelines	V1.0	http://www.imsglobal.org/ti/index.html

According to the general structure of IMS site and its specifications, whenever a more descriptive documentation is desired, it would be better to look at the "Information Model". While documents marked as draft refer to future developments.

9.3 ADL standards

Advanced Distributed Learning (ADL⁹) has defined SCORM which adds tracking to the IMS content features by

⁹<http://www.adlnet.org>

- defining a Web-based learning “**Content Aggregation Model**” and “**Run-time Environment**” for learning objects. Starting from high-level requirements like Accessibility, Interoperability, Durability and Reusability
- being based on the assumption that Web-based technologies and infrastructure are rapidly expanding and provide a mainstream basis for learning technologies allowing content to be delivered using nearly any medium (e.g., CD-ROM, stand-alone systems and/or as networked environments).
- allowing **Learner Activities Tracking** and also **Adaptive & Intelligent Tutoring**

9.4 AICC

AICC¹⁰ has the following guidelines and recommendations

AGR 001 - AICC PUBLICATIONS

Identifies and provides an abstract of current AICC Guidelines and Recommendations, technical documents, and white papers.

AGR 002 - COURSEWARE DELIVERY STATIONS

Contains recommendations to the aviation industry for the acquisition of a computer-based training student delivery station.

AGR 003 - DIGITAL AUDIO

Recommends guidelines that promote the ability of courseware with audio to playback on different PCs with different audio cards in them. It also means the ability of a single PC to playback courses with audio from different vendors.

AGR 004 - OPERATING/WINDOWING SYSTEM

Provides a formal recommendation to the aviation industry for an operating and windowing system used for delivery of CBT. It contains the results of a survey of the major operating and windowing systems conducted by the AICC.

AGR 005 - CBT PERIPHERAL DEVICES

Recommends guidelines that promote the interoperability of the following peripheral devices: video overlay card, videodisc player, and XY input device (such as a touch screen, mouse, or trackball), and part task trainers.

AGR 006 - COMPUTER-MANAGED INSTRUCTION

Recommends guidelines that promote the interoperability of CMI systems to manage CBT lessons from different origins. It also includes the ability for a given CBT lesson to exchange data with different CMI systems.

¹⁰<http://www.aicc.org>

AGR 007 - COURSEWARE INTERCHANGE

Recommends guidelines for the interchange of the elements that occur in CBT courseware including: Text, Graphics, Motion (frame-based), Audio, and Logic. These guidelines encompass: 1) The major data components of CBT courseware, and 2) Standard data formats for those components.

AGR 008 - DIGITAL VIDEO

Recommends guidelines for the creation, distribution, and use of digital video in CBT courseware.

AGR 009 - ICON STANDARDS: USER INTERFACE

Recommends guidelines for the functions of the student/user interface and their associated graphic representation in CBT courseware.

AGR 010 - WEB-BASED COMPUTER-MANAGED INSTRUCTION

Recommends guidelines that promote the interoperability of web-based CMI systems. The purpose of this AGR is to promote the same kind of interoperability as described AGR006 for Web-based CBT courseware and CMI systems.

Additional to the guidelines and recommendations, AICC also provides technical containing technical details underlying an AGR. Technical reports also represent the official word of the AICC in that they have undergone the same formal approval process as an AGR. Technical documents are identified with a prefix which designates the subcommittee from which they originate as follows:

- CMI Computer-Managed Instruction
- COM Communications
- CRS Courseware Technology
- EXC Executive Committee
- ITL Independent Test Lab
- MPD Media and Peripheral Devices
- PLT Platform
- WOS Window & Operating Systems

9.5 Conclusions

Many of the standardization initiatives mentioned above has been around for some time and there is quite a few platforms that support them. However, only a few support all of them, e.g. the Learn eXact e-learning platform.

From the perspective of LUISA these standards provides good starting points for LUISA semantic services even though the standards are not semantically enhanced themselves. Having support for import and export from these standards is crucial for integration with other systems as well as for avoiding starting with empty repositories of content.

10 DIGITAL RIGHTS MANAGEMENT

The objective of this section is to provide an overview of the current state-of-the-art related to the adoption of DRM (Digital Rights Management) technology for the delivery of digital content in the e-learning context.

DRM in e-learning has to be seen in a broad context, namely as management of relationships between the providers of the e-learning digital content and consumers (learners, teachers, etc.) in general. This is a topic of broader social, economic, legal and technical relevance concerning the ways digital information is distributed and used in an electronic environment.

DRM is not so easy to define. One possible definition is that DRM is about the electronic management and marketing of usage rights in digital content. Digital content can be text, graphics, images, audio, video or software in digital format. In e-learning, and specifically in LUISA, DRM should tackle the management of usage rights of LO. But DRM can be seen in two different ways. On the other hand, the term DRM identifies the digital management of rights, thus assuring not only security against illegal access or duplication of contents, but also involving description, identification, delivery, protection, control and tracking of every usage right for a licensed specific content.

In this double sense a DRM system typically presents the following features:

- Define a business model (rules) according to which the system is able to allow the access to contents only to authorized users.
- Manage the distributive intermediation if there are third parties involved in the process between the rights holder and the end user.
- Account accesses to contents and the relative remuneration to all parties involved in the distributing chain.
- Codify contents at the origin and to decode them for the end usage, according to the validity of the digital licence acquired by the end user and as allowed.
- Control digital licence distribution only to those who have paid to acquire a proper licence to access contents.

In addition to that, there are some techniques or technical approaches used to safeguarding the content. These are called Technical Protection Measures (**TPM**). Using Adobe as an example, users could create pdf files that disable printing or copying. It is worth mentioning that some types of TPMs do not comply with open licenses as Creative Commons Public License (CCPL, introduced below). Examples of TPMs are:

- Password protected or authenticated schemes.
- Watermarking
- Guaranteeing integrity.
- Tracking use.
- Preventing commercial use.

Use of TPMs fits more into a “rights heavy” framework, whereas license schemas such as CCPL try to make work easily and readily accessible to users. In case of open content, organizations need to assess their goals for use of CCPL licenses and the possible impact of TPMs on re-use by the end-user before implementing any TPM.

Another possibility of managing digital rights is to allow the use of the LO by using open access licenses. Using this simple approach, content retrieval and use is possible without any consideration but the stated by the licence agreement. The licenses most widely used are explained below.

The Creative Commons Public License (**CCPL**) [45] is a set of licenses schema that aims to clarify the conditions of use of a work and avoid many of the problems current copyright laws pose when attempting to share information. Each license is expressed in three ways: legal code, a commons deed explaining what it means in lay person’s terms, and a machine-readable description in the form of RDF/XML metadata. Copyright holders can choose to embed the metadata code in their HTML pages, which will then aid retrieval. The use of CCPL licences for academic resources is an area of great potential. It will allow resources to have a consistently wide impact and will help minimise difficulties in repurposing in the future. This license is becoming the most common license used in the academic world to publish articles, papers, and LO in general for open access.

Digital Peer Publishing License (**DPPL**) [44] was initially created for the authors of scientific publications with the goal of increasing the number of high-quality scientific publications as well as developing and establishing new methods of network-based cooperative information management, which will in turn enable high speed, open, and transparent digital peer publishing in an appealing environment. In practice it doesn’t differ very much from the CCPL. The only significant differences are in the specifications of retained rights but not in the application fields.

10.1 Standards in DRM

The IEEE Learning Technology Standards Committee (**LTSC**) P1484 [19] has defined the description of learning objects grouped into categories. One of these categories is the “Rights category” that groups the intellectual property rights and conditions of use for the learning object.

The **MPEG-21** [43] multimedia framework contains architectural elements that are needed to support the multimedia delivery chain, and is in the process of defining the relationships between and the operations supported by them. Within the MPEG-21 standard it is dealt with digital rights management in three parts: (i) Part 4 defines a framework for Intellectual Property Management and Protection (IPMP), (ii) Part 5 - MPEG REL (Rights Expression Language) offers a language for describing rights and (iii) Part 6 - RDD (Rights Data Dictionary) defines the terms for the REL.

Extensible Rights Markup Language (**XrML**) [42] is an XML-based usage grammar for specifying rights and conditions to control the access to digital content and services. XrML is designed to express RIGHTS, TERMS, and CONDITIONS. XrML expressions are licenses that grant rights to principles

(people or organizations) associated with resources (including LO) and subject to conditions. as is support for the identification of Web services. XrML offers a core schema, a standard extension schema intended for all uses of XrML and an additional schema intended for use with digital content or with traditional media such as books or music. The XrML data model consists of four entities and the relationship between those entities. The basic relationship is defined by the XrML assertion "grant". Structurally, an XrML grant specifies the principal to whom the grant is issued, the right that the grant specifies, the resource that is the direct object of the right verb, and the condition that must be met for the right to be exercised. XrML is being used as a base document for a standard by the MPEG-21 working group and is being further developed by a working group within OASIS. In addition, the Rights and Rules Working Group (RRWG) of the Open eBook Forum (OeBF) has selected XrML as a foundation rights expression language for developing detailed material in its Rights Grammar specification and has also established a formal liaison with MPEG-21. Several companies including Microsoft have also adopted XrML.

The Open Digital Rights Language (**ODRL**) [41] is a proposed language for the DRM community for the standardisation of expressing rights information over content, and available as "open source". It is a standard language and vocabulary for the expression of terms and conditions over assets, and is intended to provide flexible and interoperable mechanisms to support transparent and innovative use of digital resources including learning objects and other creations in digital form. ODRL has been formally adopted by the Open Mobile Alliance as the standard for rights information over mobile content, and has been published as a Note by the W3C. ODRL has also been adopted by some large companies and has been incorporated into the international COLIS Project that shows the feasibility of integrating "rights-enabled" learning objects across numerous course and content management systems, and digital repositories of learning objects. The COLIS project has proven that ODRL meets the requirements of the education sector and application profiles have been developed for IMS Content Packaging and LOM.

The Digital Object Identifier (**DOI**) [40] was developed by the International DOI Foundation (IDF). DOI is a system for assigning and resolving globally actionable unique identifiers together with a registration authority that manages the identifiers. DOI has been created with the purposes of creating a universal referencing scheme and for identifying and exchanging intellectual property in the digital environment. DOI permits the incorporation of existing identifier schemes like UPC and ISBN, it solves problems of URL persistence by providing a level of indirection, it allows descriptive metadata to be associated with digital objects by linking to metadata standards like Dublin Core, LOM, and ONIX, and it uses open standards with a standard syntax (ANSI/NISO Z39.84-2000). One of DOI's core functions is to enable automated copyright management for all types of media. To this end DOI has adopted the <indecs> approach and will implement a subset of the indecs2 dictionary. The publishing industry strongly associates digital rights management concerns with DOI

The International Digital Publishing Forum (**IDPF**) [39], formerly the Open eBook Forum (**OeBF**), is the trade and standards association for the digital publishing industry. The work of the IDPF will foster and promote the

development of electronic publishing applications and products that will benefit creators of content, makers of reading systems and consumers. Currently there is no DRM specification issued by this forum, but it is expected in the near future.

LCMS systems face increasing requirements in storage, maintenance and management of multimedia learning content to support trainers in assembling new and in adapting existing courses. A lot of research is currently underway on standardisation of LCMS objects in the form of so-called Reusable Learning Objects (**RLO's**) [23]. An RLO is a learning entity that covers a specific topic and can be reused in a different context. The SCORM standard already reflects the trend towards unified RLO specification, providing the **IMS** metadata specification as a specialized subset, which describes RLO-based content consisting of Reusable Information Objects (**RIO's**). These RIO's are typically images, text paragraphs or presentation slides. To avoid confusion RLO's are often called lessons and RIO's sections. In this context, MPEG-7's standardized descriptors can be used to provide media content description for use of RIO's in search engines. **MPEG-7** [38]. The management of RIO's and RLO's as multimedia content, whereas RLO's can be assembled using different content repositories with different access rights, raises the need for powerful rights management mechanisms.

The **OMA DRM** [37] standard membership now includes about 400 mobile operators, content, service and applications providers, wireless vendors and IT companies. Its goal is to deliver high quality, open technical specifications based upon market requirements and to reduce industry implementation effort. OMA has taken a different approach to DRM when compared to other standards groups. The alliance aims to enable content delivery in an evolutionary process by implementing basic protection as soon as possible and then taking on more complex issues, thereby avoiding spending years addressing every threat before implementing a definite standard. In line with this, OMA and its members identified the market need for various levels of protection depending on the value of the content being protected.

10.2 DRM Products

Intertrust develops and licenses intellectual property for digital rights management (DRM), digital policy management (DPM), and trusted computing. InterTrust's DRM platform is designed to implement a range of DRM functions, including persistent protection of digital information of all types and support for simple to complex business models.

FlyingMedia provides e-publishers with a sophisticated and highly flexible commerce system that is consumer-friendly, convenient, and easy to use. FlyingMedia, based on InterTrust's DRM platform, consists of packager and viewer software for published materials, and is supported by the MetaTrust Utility and clearinghouse services. Note: InterTrust was acquired by Sony of America, Koninklijke Philips Electronics N.V., and another investor.

ContentGuard

The company is focused on creating a worldwide standard Digital Rights Language. It believes that such a standard will enable interoperability across

DRM systems for digital content or services, including web services. Towards this end, ContentGuard has proposed XrML to numerous standards bodies and provides technical expertise in support of their work. MPEG, officially known as ISO/IEC JTC1/SC29/WG11, selected XrML as the basis for the development of the MPEG-21 REL.

ContentGuard's open platform enables the preparation and delivery of secure content in a range of formats, including Microsoft Word and .lit files, and Adobe PDF. ContentGuard will also use Adobe PDF Merchant within its own XrML website to enable developers to securely download the rights specification language, available free-of charge, in Adobe PDF. Adobe's PDF Merchant software secures digital content for distribution and sales via the Internet, providing the security and confidence needed when distributing and selling titles in electronic format.

iCopyright

iCopyright will facilitate Digital Object Identifier (DOI) registration for the content of its Instant Clearing Service customers, and Content Directions will offer its own customers DOI-based linking to iCopyright's rights clearance, reprint rights, and permissions services. iCopyright will also promote Content Directions to its customer base as the premier DOI Registration Agency, and Content Direction will promote iCopyright as its recommended rights and permissions agent. They use ICE & News ML standards for DRM. They don't encrypt content. Their solutions integrates the following major components: e.commerce system, web servers, content management system, content rendering application (e.g Real player, Acrobat Reader)

Adobe PDF Merchant is a server-based technology designed to be integrated into existing ecommerce and transaction servers. It manages encryption of PDF files and the distribution of keys to access them.

Learn eXact is Giunti Interactive Labs' integrated suite for creating, managing and delivering e-learning content based on learning objects. It is not a DRM system, but Learning Content Management System (LCMS), XML and international AICC, IMS and SCORM interoperability specifications, are part of this product.

Among big companies, **Microsoft** core DRM technology is "**Windows Media Rights Manager**," an end-to-end system that supports the secure delivery of digital media content as it travels across the Internet and between devices. Rights Manager supports a broad array of distribution and business models, including real-time streaming of digital content. Product features include: secure packaging and distribution, flexible licensing rules, and the ability to upgrade and repair. Microsoft's "Digital Asset Server" is Microsoft's solution for electronic publishing. Another example is **IBM** Electronic Media Management System (**EMMS**) is an integrated DRM system that enables users to process media business data to package content with associated digital rights into encrypted containers for distribution to EMMS content delivery networks, retailers and enterprise portals. IBM's Digital Media Solutions, a portfolio of applications that incorporates an open and standards-based framework, assists companies to create, manage, distribute, trans act and protect their content.

10.3 Open Source DRM systems

Two of the most important Open Source DRM systems are listed below:

Opera

The Eurescom project OPERA (P1207) [36] is specifying and prototyping an open DRM architecture, enabling the interoperability between different DRM systems. The OPERA architecture adds two additional capabilities to common DRM frameworks:

- The usage license is independent of the underlying DRM system.
- The usage license is bound to a user instead of, as is common with existing solutions, to a device.

Opera aim to create a DRM architecture implementing standardized interfaces and processes for the interoperability of DRM systems, independent of hardware, OS, and media formats. Will theoretically enable user-based rather than device-based license provision. OPERA achieves interoperability among DRM systems -- interoperability between Microsoft and RealNetworks DRMs has already been demonstrated -- essentially by reducing DRM licenses down to a lowest common denominator of authenticating users only and providing "play once" as an atomic licensing term that all DRM systems can understand and support. Each of the DRM systems involved in a specific instance of interoperability can manage more complex licensing terms internally and communicate them through the OPERA architecture via "play once" licenses.

The system distinguishes between licensees of the underlying DRM systems and 'OPERA licenses'. While the OPERA licenses support several usage rules, OPERA itself needs only a 'play-once' license from the underlying DRM systems. The advantages of this approach are:

- Independent license management, which facilitates the content import for content providers.
- Support for a wide range of usage rules, even though they are not available on the target DRM system.
- Automated license recovery for every connected DRM system even though the DRM system itself is not able to recover licenses.
- Secure storage of the valuable licenses and content for the user.
- Independence from the end user device.

Sun DReaM DRM

Sun Microsystems introduced Project DreaM [35] (DRM/everywhere available), a project to create an open-source standard for interoperable DRM. The standard calls for DRM that relies on user authentication alone and does not bind content to hardware devices.

Project DReaM is an initiative to develop an open Digital Rights Management (DRM) solution for multiple domains (media, documents, enterprise, personal, etc.). This open source project develops an end-to-end Reference Implementation for the DReaM Specifications in order to enable a quick-start for DRM solutions.

The project is giving the initial contributions, as the DRM InterOPERability Framework, an interoperable DRM architecture implementing standardized interfaces and processes for the interoperability of DRM systems. It enables user-based license provisions as opposed to the situation today where licenses are assigned to devices. Another contributions are the Java Stream Assembly and Sun Streaming Server, to manage video-stream.

10.4 European Initiatives

During the last years the European legislator introduced new regulations concerning protection and enforcement of intellectual property rights with a major role for DRM systems, in particular: Directive 2001/29 (cf. sources) and 2004/48/EC (Enforcement of Intellectual Property Rights; cf. Sources) [34].

Directive 2001/29 establishes a framework which balances incentives to create and distribute content –serving the interest of the public (and individual users) – with mechanisms ensuring appropriate revenue through the exercise of intellectual property rights.

Despite the stated goal of harmonising national copyright legislations, the implementation of the 2001 Directive has not yet achieved much in making the exceptions in the field of educational uses converge. As a consequence we will have to deal with national copyright legislations that do not include an exception in relation to educational and scientific use, in the broadest meaning possible, but with a narrower scope of application. It is therefore crucial to find and support best practices that demonstrate the actual possibility to combine copyright protection and effective access to content by educational organisations and individual learners.

One of the conclusions of the Commission's working paper "Digital Rights. Background, Systems, Assessment" was that DRM was at that time neither widely deployed nor widely accepted. Therefore a number of issues were presented, which needed to be taken into account to ensure wide acceptability of DRM and to overcome certain obstacles. These issues were both technology and user-related.

From 2002 the European Commission organised workshops and working groups on DRM, bringing together representatives of the main stakeholders (industry, consumer rights groups and other interested parties) in an effort to promote and gather views on the acceptability of DRM systems for the lawful distribution of digital content.

There are some projects on DRM financed by the commission. Some of these projects are listed below:

- **INTEROP [33]**, established in November 2003, is a FP6-funded project set up as a 'network of excellence' which aims to create the conditions of an innovative and competitive research in the domain of interoperability for enterprise applications and software. One focus of interest to the INTEROP project is the DRM standardisation. The duration of the project is 3 years.
- **INDICARE [32]**, running under the eContent programme, is scheduled for two years, starting on 1 March 2004. INDICARE was set up to raise

awareness and support the emergence of a common European position with regard to consumer and user issues of DRM solutions. One of its main goals was to build consensus among the heterogeneous interests of multiple players in the digital environment. Therefore it intended to establish and maintain a neutral, pre-competitive and pre-regulatory environment for discussion and informative exchange, called Informed Dialogue. Issues regarding consumer and user acceptability of rights management solutions have been addressed in this Informed Dialogue. These issues included aspects such as the interface and functionality of DRM systems, policy issues linked to privacy, access to information, the legitimate use of content and business models or ease of access, etc.

- **ORMEE [31]**, Observatory on Rights Management for e-learning in Europe is a project in the framework of e-learning programme that finalised at the end of 2005. The project was aimed at creating an European observatory on copyright on educational content to be used in e-learning and the analysis of the implementation of the EU Directive on Copyright in the Information Society. OrmeE is about the “state of the art” in the implementation of the EU Copyright Directive in all the European countries, with particular attention paid to the regulations adopted in each country as far as “educational” exceptions are concerned and the possible consequences of different regulations in the educational content market.

The ORMEE project defines several business models in the DRM e-learning scenario. LUISA fits in the model 8: “E-learning environment offers services and gathers educational content”. The ORMEE project states that it is rather difficult to classify this kind of business model because there are many different stakeholders along the value chain. Content could be developed and implemented either directly by users or user communities, or by commercial content providers (educational publishers, e-learning content providers, etc.), or by pools of experts involved in the project. They think that this is a very interesting business model as most stakeholders (teachers, learners, or other users) are directly involved in the process of content creation and knowledge growth. Therefore they feel more engaged. But for ORMEE it is however not clear how the relationship (even economic) between the parties shall be regulated.

10.5 Conclusions

This section has provided an overview of the state-of-the-art in the management of digital rights. On the one hand, the need of defining a business model to allow access to the learning contents has been discussed. Related to this issue, the use of TPM or open licenses such as creative commons has been presented. Later the some standards and commercial or open source applications in the DRM arena were depicted. Finally, the European legislation, initiatives and major projects were brought into scene.

Although it is not very clear how LUISA will deal with DRM issues, the idea of building on top of standards will enable LUISA to perform integration activities between different LCMSs. This integration will be reached due to the interoperability offered by the Web Services infrastructure and the use of

standards for the description and the relationship of Learning Objects. These issues require a DRM module that ensures the proper access to the content stored in different LCMSs. It is recommended to have a look at the management of digital rights that different LCMS systems (specially Learn eXact and Moodle) have already in place.

It is also recommended to take into account the results and reports of the INDICARE and ORMEE projects, because the first one is a DRM observatory and the second a DRM e-learning-focused project.

11 CONCLUSION AND IMPACT

In this report we have presented the state of the art in the fields of Semantic Web Services, Annotation, LCMS, and DRM. The background and the technical analysis is the point of departure for much of the technical development within LUISA. Several important decisions on technology will be made on the basis of recommendations of this report. These recommendations reflects the latest development, relevance to the project and feasibility within the projects time frame.

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